Diseases of penguins

Thirteen of the world's 16 penguin species (family Spheniscidae) occur in New Zealand's maritime territories. Four are either rare or only locally common endemics and, of the remaining species, five breed here and four are non-breeding visitors. The endemic and endangered yellow-eyed penguin or hoiho (*Megadyptes antipodes*) is locally distributed on the South Island, Stewart Island, Codfish Island, the Auckland Islands and Campbell Island. The rarest penguin species in the world, its population has declined dramatically on the South Island. Fledglings go to sea in February and March and half die of malnutrition during their first five weeks at sea resulting in a peak of beach-cast mortality in May and June. The Fiordland crested penguin or tawaki (*Eudyptes pachyrhynchos*) is also an endangered endemic that has a restricted breeding distribution from Westland to Stewart Island. Most beach-cast mortality occurs from October to February when fledglings go to sea and breeding adults begin to moult. Related endemic species are the Snares crested penguin (*E. robustus*) and the erect-crested penguin (*E. sclateri*). The former is locally abundant on the Snares Islands where the only nesting sites occur. The latter breeds on subantarctic islands including the Antipodes, the Bounties, and on Disappointment Island in the Auckland Islands. Outside the breeding season individuals of both species disperse widely and have been recorded regularly in Australia. Fledgling Snares crested penguins are occasionally found wrecked on Southland beaches in summer. Low numbers of erect-crested penguin fledglings are found beach-cast on the southeast coast of the South Island during March and April.

The native species with the most northerly breeding distribution, extending from Northland to Stewart Island and the Chatham Islands, is the blue penguin or korora (*Eudyptula minor*). At least five phenotypic variants, or subspecies, occur around New Zealand; one is known as the white-flippered penguin. Blue penguins are common and frequent the Hauraki Gulf, Cook Strait, Kapiti coast, Otago, Foveaux Strait and the Chatham. Between 1960 and 1982 almost 16,000 were recorded in beach surveys for sea bird mortality. This figure includes unusual mortalities (wrecks) such as the 3,729 blue penguins found dead on Auckland's east coast beaches in 1974 and a similar event in Northland in 1973-74. Annual mortality peaks from January to March, coinciding with fledging and the molting period of breeding birds. The subantarctic islands (Aucklands, Campbell, Bounties, Antipodes, Snares) are frequented by ten penguin species and four regularly breed there. The yellow-eyed penguin is a solitary-nesting species while the other three species are colony-nesting crested penguins and include the Snares crested and erect-crested penguins. The smallest of the group, the eastern rockhopper penguin (*E. chrysolophus fúhlohi*), occurs locally on New Zealand's subantarctic islands and on Macquarie Island in Australian territory. Two other rockhopper subspecies, *E. chrysolophus* and *E. c. mosselyi*, are vagrants. Crested penguins breed and moult ashore and then spend about four months foraging at sea over the winter.

In recent years there has been a dramatic decline in the number of erect-crested and rockhopper penguins. The former has decreased by 20% on the Antipodes since the mid 1990s and the latter by about 90% over the past 50 years on Campbell Island. Although the factors responsible have yet to be established, the circumpolar decline of rockhoppers suggests widespread environmental changes (D Thompson, ESR, personal communication). Declines of yellow-eyed penguins have been attributed to disturbance, habitat loss, introduced predators, periodic food shortages, and fluctuations in climatic variables such as rainfall and sea surface temperatures.

In Antarctica, New Zealand's Ross Dependency has three breeding penguin species including the emperor (*Aptenodytes forsteri*), Adélie (*Pygoscelis adeliae*), and chinstrap (*P. antarctica*). Visitors and vagrants to the New Zealand region include the two subspecies of *E. chrysolophus* (the royal and macaroni), king (*A. patagonicus*), and gentoo penguin (*P. papua*), whose closest breeding colonies are on Macquarie Island and Heard Island. The Magellanic penguin (*Spheniscus magellanicus*) is a rare vagrant from South America.

The threats to the various species in New Zealand territories include predation by introduced mammals, habitat alteration and disturbance, competition for resources, and incidental mortality by commercial fisheries. Infectious diseases and parasites may also compromise the survival of individuals or relict populations and are the subject of this review.

Infectious diseases

The literature on infectious diseases of New Zealand’s penguins is patchy with few directed studies on endemic diseases. Several penguin species have received little attention apart from cataloguing parasites. With little information on endemic disease, the risks from potentially exotic diseases are largely unknown.

Viral infections

A 1988 serological survey on a limited number of rockhopper and yellow-eyed penguins on Campbell Island reported no antibodies against a panel of poultry viruses including the agents of infectious bronchitis, reticuloendotheliosis, Newcastle disease, infectious laryngotracheitis, avian encephalomyelitis, infectious bursal disease, Marek’s disease, and fowlpox. Paramyxoviruses: Nine paramyxovirus isolates were recovered from cloacal swabs collected between 1976 and 1979 from royal and king penguins on Macquarie and Heard Islands in Australia’s...
One isolate was indistinguishable from viruses of PMV-1 serotype (lentogenic Newcastle disease virus, NDV). No viruses were isolated from either gentoo or rockhopper penguins. King, royal and rockhopper penguins sampled at several sites had antibodies against one of the isolates and royal penguins were seropositive for NDV. Antibodies against the same viruses were also detected in sera from a few blue penguins sampled along the Victorian coast of Australia.

In Antarctica, paramyxoviruses were isolated from Adélie penguin cloacal swabs at several rookeries between 75°E (Davis Station) and 170°E (the Ross Sea). A serological survey of seven colonies found that infection was widespread close to Casey Station in Australian territory and the French base of Dumont d’Urville. However, no seropositive birds were detected at 13 sites near the Davis Station in Australian territory. It appears that titres may be elevated only transiently following infection and this may influence seroprevalence data.

Based on antigenic and biochemical characteristics, the penguin paramyxoviruses are distinct from those of other avian species but some isolates share epitopes with PMV-1 isolates from the northern hemisphere. The significance of infection for free-living birds is unknown but the isolates were not pathogenic for chickens or blue penguins. However, infection could predispose penguins to opportunistic infections or confer immunity against pathogenic viruses such as NDV. Antibodies against the latter were detected in the serum of Adélie and royal penguins. The significance of NDV for free-living birds is unknown but mortalities have occurred among Adélie penguins and in a captive king penguin. The Adélies were captured in 1973 near Scott Base in the Ross Sea and shipped to the United States where several birds died from an infection characterised as velogenic neurotropic in chickens. It was believed that infection was contracted in the wild because the birds were maintained in quarantine.

**Orthomyxoviruses:** Avian influenza virus antibodies, but not clinical disease, were found in Adélie penguins from Casey Station and the Ross Sea in Antarctica. Antibodies against a Flavivirus have been found occasionally in sera from king, royal, Adélie, and rockhopper penguins. A new Flavivirus, Bunyavirus, and Orbivirus were isolated from ticks collected from penguins on Macquarie Island, which suggests several possibilities for the low prevalence of antibodies: transmission rates may be low, penguins may be a dead-end host, or disease may be fatal and few birds seroconvert and survive. Recently, a new arbovirus (Family Togaviridae, genus Alphavirus) was isolated from lice collected from elephant seals on Macquarie Island. Further characterisation is required for these novel wildlife viruses.

**Birnaviruses:** Infectious bursal disease virus (IBDV) occurs as avirulent strains and a highly virulent strain. Even the avirulent strains can cause growth retardation and immunosuppression. Antibodies against IBDV were detected in sera from emperor and Adélie penguins in Antarctica but there was no evidence of disease. Adélie chicks at a colony remote from human activity were seronegative, suggesting that the virus may have been introduced into Antarctica with contaminated poultry products.

**Unclassified RNA virus:** The significance of an uncharacterised RNA virus isolated from a pool of ticks from rockhopper penguins on Campbell Island has not been established and antibodies were not present in rockhopper or yellow-eyed penguins. It is unlikely to be associated with the species’ decline.

**Herpesviruses:** A herpesvirus caused laryngotracheitis-like infection in African black-footed penguins at a zoo in North America. The disease has not been reported for any free-living penguin species.

**Suspected viral mortalities:** In 1972, an unusual event killed 65% of Adélie penguin chicks near Mawson Station, Antarctica. Moribund chicks were in good body condition but were recumbent and would stagger and fall forward when righted. The cause was not established but it was not starvation as occurred in 1995. A mass mortality among gentoo penguins at Signey Island involved several hundred birds that were in good body condition, but each had focal ulcers on the dorsal surface of the feet. No aetiology was established.

In 1981, an unusual number of four- to five-week-old Adélie chicks died on Petersen Island (near Casey Station). No clinical signs were
observed and no necropsies conducted. However, five of 55 adult birds were seropositive for influenza antibodies\(^{18}\). Although unlikely, the virus may have been implicated.

### Bacterial and fungal diseases

**Enteric bacteria:** Many bacteria have been isolated from free-living penguins but only a few are pathogens\(^{12,13,14}\). Five *Salmonella* serotypes were isolated from Adélie penguins on Ross Island, Antarctica, but were not associated with disease\(^{20}\). *Campylobacter* spp, with only minor sequence difference in 16sRNA from *C. jejuni* and *C. lari*, were isolated from marine birds including apparently healthy gentoo and macaroni penguins sampled on Bird Island, South Georgia\(^{20}\). Whether these enteric bacteria are normal flora of penguins is not known. It is possible that bacteria were brought to Antarctica or subantarctic islands on contaminated poultry products and disseminated through penguin rookeries by scavengers such as skuas and giant petrels. Migratory sea birds may also act as vectors of infection to penguin species that are restricted to the subantarctic or Antarctic\(^{21}\).

**Psittacosis:** Antibodies against *Chlamydia psittaci*, the cause of avian psittacosis, were found in emperor, rockhopper, royal, gentoo and Adélie penguins\(^{38,39}\). There was no evidence of disease and the origin and significance of infection are unknown.

**Pasteurellosis:** *Pasteurella multocida* of similar serotype to that which causes avian cholera epidemics among North American waterfowl was isolated from several septicemic rockhopper penguins on Campbell Island\(^{41}\). Norway rats (*Rattus norvegicus*) appear to be associated with the disease. The eradication of rats from Campbell Island over the winter of 2001 may reduce the prevalence of infection and establish whether it is implicated in the rockhopper decline on the island.

**Borreliosis:** Antibodies against *Borrelia burgdorferi*, the cause of Lyme disease in mammals, were detected in king penguins on the Crozet Archipelago, French subantarctic\(^{48}\). The bacteria were also isolated from *I. uriae*, a likely vector. Infection rarely results in disease in birds but it is a potential zoonosis.

**Aspergillosis:** Caused by *Aspergillus fumigatus*, and rarely *A. flavus*, *A. niger* or *A. terreus*, aspergillosis is commonly diagnosed in captive penguins but is rare in free-living birds. However, pulmonary infection has been recorded in emaciated beach-cast juvenile little blue penguins\(^{42,43}\). Lesions have also been reported in wrecked blue penguins in New Zealand (see table) and in a yellow-eyed penguin juvenile\(^{46}\).

*Aspergillus* spp are ubiquitous and even found in soils and skua nests in Antarctica\(^{45}\). A serological survey of penguins from New Zealand (yellow-eyed and blue), the subantarctic (yellow-eyed and rockhopper), and Antarctica (Adélie), found an inverse relationship between seroprevalence and latitude; all blue penguins from Napier were seropositive but none of the Adélies\(^{46}\).

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Blue penguin</th>
<th>Yellow-eyed penguin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starvation</td>
<td>34 (13%)</td>
<td>2</td>
</tr>
<tr>
<td>Starvation and parasitism(^1)</td>
<td>15 (6%)</td>
<td></td>
</tr>
<tr>
<td>Starvation and trauma</td>
<td>1 (0.004%)</td>
<td></td>
</tr>
<tr>
<td>Starvation and neurological signs(^2)</td>
<td>1 (0.004%)</td>
<td></td>
</tr>
<tr>
<td>Trauma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dogs</td>
<td>35 (14%)</td>
<td></td>
</tr>
<tr>
<td>Mustelids (ferrets)</td>
<td>20 (8%)</td>
<td></td>
</tr>
<tr>
<td>Shark(^3)</td>
<td>8 (3%)</td>
<td></td>
</tr>
<tr>
<td>Vehicles</td>
<td>32 (13%)</td>
<td>1</td>
</tr>
<tr>
<td>Vandalism</td>
<td>10 (4%)</td>
<td></td>
</tr>
<tr>
<td>Traps</td>
<td>3 (1%)</td>
<td></td>
</tr>
<tr>
<td>Undetermined</td>
<td>27 (11%)</td>
<td></td>
</tr>
<tr>
<td>Wrecks (multiple starvation mortalities)(^4)</td>
<td>8 (3%)</td>
<td></td>
</tr>
<tr>
<td>Bacterial infection(^5)</td>
<td>5 (2%)</td>
<td></td>
</tr>
<tr>
<td>Plasmodium-like infection(^6)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Aspergillosis(^7)</td>
<td>8 (3%)</td>
<td></td>
</tr>
<tr>
<td>Drowning(^8)</td>
<td>10 (4%)</td>
<td></td>
</tr>
<tr>
<td>Undetermined</td>
<td>36 (14%)</td>
<td></td>
</tr>
</tbody>
</table>

1. One blue penguin was under rehabilitation for seven days and at necropsy also had mycotic pneumonia (Aspergillosis). The parasite burdens included some or all of the following: Cryptosporidium sp nematodes on the proventriculus, Tetrabothridium cestodes in the intestine, *Renicola* trematodiasis of the kidney, intestinal and renal coccidiosis. One bird had haemorrhage from a proventricular ulcer that was probably parasite-induced.
2. One blue penguin was reported to display neurological impairment but no histological lesions were detected. The signs were possibly biotoxin-induced.
3. Inferred from linear lacerations in skin and plumage feathers\(^16\).
4. The eight birds in this submission were juveniles found wrecked at the same time on the Coromandel Peninsula.
5. Presumptive diagnosis based on gross and histological lesions.
6. Acute multifocal necrotising hepatitis, splenitis and myocarditis associated with intracellular protozoa, species not determined.
7. Aspergillosis was the only significant finding reported.
8. Drowning diagnosed from the location of the carcass and postmortem finding of fluid in lungs and air sacs\(^25\).

### Metazoan and protozoan parasites

Helminths, ectoparasites, and protozoa of penguins have been comprehensively reviewed and catalogued\(^{41,42,43,44}\).

**Ectoparasites:** Fleas, ticks, mites and biting lice occur on most penguin species. The tick *Ixodes uriae* has a wide distribution on seabirds in both hemispheres. Three other species have also been recorded on blue penguins: *I. kohlsi*, *I. auritulus* and *I. eudyptidis*. Colony-nesting species have the highest parasite burdens and ticks are most commonly found on chicks around the face, ear canals, cloaca and feet. Species affected include emperor, Adélie, gentoo, royal, rockhopper, blue and Snares crested penguins. Heavy infestation may cause death of chicks and occasionally adults. Of greater significance may be the potential for transmission of viral infections. Paramyxoviruses and arboviruses were isolated from *I. uriae* from royal and king penguins on Macquarie Island\(^{42,43,44}\). An uncharacterised enveloped RNA virus, morphologically but not antigenically similar to infectious bronchitis virus of chickens, was isolated from *I. uriae* from Campbell Island rockhopper penguins\(^{44}\).
Biting lice (*Austrogoniodes* sp) have been recorded on all species of Antarctic and subantarctic penguins except gentoo and chinstrap penguins (45)(46). Fleas (*Paraptylus* sp) are also common in the subantarctic and temperate zones and have been found on blue, rockhopper, gentoo, macaroni, Magellanic, and yellow-eyed penguins. Fleas need a suitable nest environment and spend only part of their life on the birds. Lice and fleas are of little pathogenic importance but numbers may be increased on birds that are debilitated and not preening properly (41). They may also transmit viruses.

**Helminths:** Cestodes, nematodes, trematodes, and acanthocephalans are common in most penguin species. Blue penguins in North Otago had lower than expected burdens (49). Four species of *Contraacaeum* (gastric nematodes) have been recorded, and may be associated with erosion and ulceration leading to haemorrhage. Infection rates in South Island yellow-eyed penguins were high for chicks and moderate for adults but parasite burdens were low and no pathology was observed (41)(46). Although nematodes probably do not directly contribute to the population declines observed for several New Zealand penguin species, they may be a factor (41)(43)(45). Cestodes of the genus *Tetrabothrius* occur in the intestines of blue, emperor, king, gentoo, Adélie, rockhopper and Magellanic penguins. Their life cycle is unknown but it may involve euphausid crustaceans as intermediate hosts (41). Acanthocephalans are rarely reported from marine birds but comprised 1.3% of helminths in a sample of 20 yellow-eyed penguin chicks (46). *Corynosoma* sp has also been reported for gentoo penguins (46). Both are an unlikely cause of significant disease among penguins.

Several trematode species reside in the liver, gall bladder, and intestines of penguins (46). Most are probably well tolerated but the hepatic fluke *Mawsonotrema eudyptulae* contributes to the mortality of juvenile blue penguins periodically wrecked in Victoria and New Zealand (31)(32)(33)(34). Trematodes may exacerbate the effects of starvation in recently fledged birds. Heavy burdens of flukes were noted in the kidneys of wrecked blue penguins in Northland, but with minimal pathology (45). The species was not identified but it is probably of the family Echinostomatidae.

**Coccidiosis:** Oocysts were detected in the faeces of free-living yellow-eyed penguins in Otago but the species was not determined because they could not be sporulated (46). The low prevalence of infection suggests that it is not significant. Both intestinal and renal coccidiosis have been recorded in wrecked blue penguins in Victoria (45)(46). Oocysts were found in faeces of five of 48 birds but on histology, schizonts were detected in the intestinal mucosa of only one (46). By contrast, 64% of birds had chronic interstitial nephritis and ureteritis associated with coccidia. However, the lesions were mild and focal and probably of little pathological significance (46). Intestinal coccidiosis was reported for wrecked blue penguins in Northland but lesions were not described (46).

**Haematozoa:** A novel blood parasite, *Leucocytozoon tawaki*, described from blood smears from free-living Fiordland crested penguins (49), is transmitted by blackflies (*Austrosimulium* spp) and is probably not pathogenic. It was not found in blood smears from 25 Snares crested penguins and one erect-crested penguin on the Snares (41). *Trypanosoma eudyptulae* was described from smears from blue penguins in southeastern Tasmania (54). The intermediate host was not identified but ticks were proposed. Infection appears to cause no disease in penguins.

**Malaria:** Avian malaria caused by *Plasmodium relictum* is an important cause of mortality among captive penguins in North America and Europe (51), and also among free-living blue penguins in Australia (46) and African black-footed penguins (57)(58). Infection in the latter lasts for life and stress such as oiling or transportation may induce recrudescence (59)(60). Parasitaemia underestimates infection but an enzyme-immunoassay detected a high seroprevalence (up to 100%) in yellow-eyed penguins on Banks Peninsula, Otago Peninsula, Catlins, Codfish Island, Enderby Island (the Aucklands), and Campbell Island (43)(45). Only 10% of yellow-eyed penguins sampled on Stewart Island had *P. sphenicidae* parasitaemia (58) and none of 189 blood smears from 83 free-living yellow-eyed penguins on Banks Peninsula had demonstrable haemoparasites (S McDonald, personal communication).

Despite the apparently high level of exposure of yellow-eyed penguins to *Plasmodium* sp, the incidence of clinical disease appears to be low. The cause of the deaths of 150 adult penguins on Banks Peninsula during the summer of 1989-90 was not established (41). Avian malaria was suggested as the aetiology based on elevated antibody titres in plasma from dead birds (46). However, the investigators found no histological lesions characteristic of malaria and proposed that acute intoxication by a marine algal neurotoxin was more likely, based on clinical signs, pathology and environmental conditions (J Gill, personal communication).

Whatever the cause of that event, a recent case on Otago Peninsula shows that avian malaria has the potential to cause mortality among yellow-eyed penguins. In February 2001, a juvenile in good body condition was found dead without gross lesions. On histology, there was extensive acute necrosis and inflammation of the myocardium, liver and spleen associated with intracytoplasmic *Plasmodium*-like parasites (57). Similar pathology was also described for a captive Fiordland crested penguin in Australia (46).

No haematozoa have been detected in blood smears from king, royal, and gentoo penguins on Macquarie Island, king and macaroni penguins from Heard Island, and Adélie and emperor penguins from Antarctica (53)(54). Serology confirmed the absence of infection from Adélie penguins on Ross Island, Antarctica, suggesting that a suitable vector is absent from polar latitudes (53). However, at least some penguins that inhabit the subantarctic islands appear to be exposed. King and gentoo penguins on the Kerguelen and Crozet Islands in the subantarctic had antibodies as did yellow-eyed penguins on the Aucklands and Campbell Island, but rockhoppers...
on Campbell Island did not\(^{(62)}\). Suitable vectors are probably absent from Antarctica but may be present in the subantarctic. Alternatively, penguins that breed on subantarctic islands may be exposed to vectors if they migrate to lower latitudes outside the breeding season.

High seroprevalence of malaria was reported in captive blue penguins in Napier\(^{(61)}\) and in free-living birds from Codfish Island, to the west of Stewart Island\(^{(62)}\). Mortality has not been reported in New Zealand but does occur among blue penguins in Australia\(^{(49)}\).

Other protozoa: A blue penguin that died of toxoplasmosis while under rehabilitation in Tasmania had been fed on uncooked meat and held in a household with several cats\(^{(66)}\). A tick-borne piroplasmid, presumed to be *Babesia* sp, has also been found in blue penguins in Australia where it causes mild regenerative anaemia in juveniles (Cunningham cited by Clark and Kerry\(^{(46)}\)).

**Non-infectious causes of mortality**

**Starvation**

Juvenile blue penguins appear susceptible to periodic mass mortalities that may reflect fluctuations in prey availability. Rockhopper penguins may also be susceptible to fluctuations in prey availability that are influenced by the El Niño-Southern Oscillation\(^{(67)}\). Blue penguin wrecks have been recorded in New Zealand since the early 1940s\(^{(68)}\). During two large wrecks in Northland in July-August 1973 and April-May 1974, there was a hundredfold increase in the number of beach-cast birds\(^{(6)}\). Most were immature females in poor body condition with an empty gastrointestinal tract, depleted fat reserves, muscle atrophy, and moderate parasite burdens. It was concluded that death resulted from starvation exacerbated by parasitism and bad weather, as was proposed for a wreck of mixed-age blue penguins on the Victorian coast between December 1977 and June 1978\(^{(41)}\). A wreck of blue penguins in South Australia and Victoria in March-April 1986 also involved emaciated and parasitised juvenile birds that washed ashore following southerly storms\(^{(50)}\).

During the summer of 1989-90 a catastrophic event claimed at least half of the adult breeding population of yellow-eyed penguins on the Otago Peninsula\(^{(42)}\). Moribund birds were neurologically impaired and dead birds were in good body condition with no evidence of infectious disease, suggesting that marine algal bioxins may have been implicated (J Gill, personal communication). Over the past two decades marine dinoflagellate blooms have claimed a variety of marine vertebrates worldwide ranging from fish and sea birds\(^{(69)}\), to pinnipeds\(^{(70)}\), sirenians\(^{(71)}\), and cetaceans\(^{(72)}\). Blooms of neurotoxin-producing diatoms occur frequently in New Zealand waters and have the potential to cause neurological signs and death in penguins eating prey that has accumulated the toxin\(^{(73)}\). Laboratory assays to detect these biotoxins are now available in New Zealand.

**Mortality in New Zealand**

Since 1991, diagnostic laboratories have received, and entered on the wildlife pathology database (*Huia*), 34 submissions of blue penguins and four of yellow-eyed penguins. Each case was re-evaluated for this review. An additional 213 blue penguins from northern Otago were examined between 1994 and 1998\(^{(13)}\). The diagnoses from both sources are summarised in the table.

**Conclusions**

Most of the disease surveillance on penguins has occurred in the Antarctic and subantarctic. The focus has been on potentially exotic diseases that may have been introduced through human traffic to these once remote regions. The risk has been minimised by a protocol on Environmental Protection (Madrid, 1998) as part of the Antarctic Treaty, 1991. This banned the importation of live poultry and other birds into the Antarctic and requires the inspection of dressed poultry for Newcastle disease and tuberculosis. However, the international regulations are less strict than national quarantine measures and there are no protocols to control outbreaks of disease should they occur in Antarctica\(^{(74)}\). In New Zealand, the Department of Conservation bans the transportation of poultry or poultry products, apart from eggs, to the subantarctic islands. Tourist vessels do carry such products but are not permitted to discharge organic waste in the vicinity of islands. However, the risks posed by tourist and fishing vessel traffic are largely unknown.

Clearly more surveillance is required for penguins in New Zealand territories. Of the four endemic species, two are endangered (yellow-eyed and Fiordland) and a third (erect-crested) is in decline. There have been no studies on disease or mortality factors among Snares crested penguins, Fiordland crested penguins, or...
erect-crested penguins, apart from scattered records of parasite occurrence. Studies on yellow-eyed penguins have also been limited to serology for avian malaria and aspergillosis, and opportunistic sampling of wrecked birds. The alarming decline of rockhopper penguins on Campbell Island prompted a limited disease investigation in the mid 1980s[14]. No firm conclusions could be drawn other than the suggestion that avian cholera was probably not implicated. A novel enveloped RNA virus was isolated but not fully characterised and its pathogenicity not established. Research is continuing into the associated environmental factors but disease is not included (D Thompson, personal communication).

At the least, baseline serology should be conducted on all endemic and native species breeding in New Zealand territories. A serum bank should also be established to facilitate retrospective studies if an outbreak of a suspected exotic disease occurs in future. Without establishing what diseases may be endemic, it is not possible to speculate further on the disease risks from introduction of exotic birds or vectors or even from domestic avian species.

Acknowledgements
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Avian leukemia subgroup J in New Zealand

The avian leukemia group of diseases is caused by retroviruses and comprises a variety of transmissible benign and malignant neoplasms of chickens. Six subgroups of avian leukemia viruses (ALV) have been isolated from chickens: A, B, C, D, E, and J(5). Tumours associated with ALV-J occur in adult meat-type chickens of both sexes and most are a myeloid leukaemia with enlargement of the liver, spleen, and kidneys. Tumours of other organs and of the skeleton have also been observed. Mortality from tumours varies, and factors such as chicken type, line, age, immune and disease status, and husbandry practices may have an influence(6).

ALV-J can spread horizontally and vertically and, depending on the age and line of chickens that are infected, there are a number of possible outcomes with respect to antibody and virus status.

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A pilot survey to determine avian leukemia subgroup J status using ALV-J ELISA was conducted in 1998/99 and identified seropositive birds in commercial meat-type chicken flocks. Most of the positives were found in chickens aged 31–50 weeks. Suggestions are made for further investigation.

Wlodek L Stanislawek

Infection of embryos of any line results in permanent immunologically tolerant, antibody-negative, viraemic chickens, which shed virus into the cloaca and albumen. These birds are particularly prone to developing myeloid leukaemia and tumours. If leghorn chickens are infected at one day of age, they become